# Appendix C. Source and Reliability of Estimates

## SOURCE OF DATA

The data were collected during the fifth wave of the 1984 panel of the Survey of Income and Program Participation (SIPP). The SIPP universe is the noninstitutionalized resident population of persons living in the United States.[1] However, this report excludes information collected from the farm population and persons living in group quarters.

The 1984 panel SIPP sample is located in 174 areas comprising 450 counties (including one partial county) and independent cities. Within these areas, the bulk of the sample consisted of clusters of 2 to 4 living quarters, systematically selected from lists of addresses prepared for the 1970 decennial census. A small sample of living quarters built after the 1970 decennial census was also selected.

Approximately 26,000 living quarters were designated for the sample. For Wave 1, interviews were obtained from the occupants of about 19,900 of the designated living quarters. Most of the remaining 6,100 living quarters were found to be vacant, demolished, converted to nonresidential use, or otherwise ineligible for the survey. However, approximately 1,000 of the 6,100 living quarters were not interviewed because the occupants refused to be interviewed, could not be found at home, were temporarily absent, or were otherwise unavailable. Thus occupants of about 95 percent of all eligible living quarters participated in Wave 1 of the survey.

For the subsequent waves, only original sample persons (those interviewed in the first wave) and persons living with them were eligible to be interviewed. With certain restrictions, original sample persons were to be followed if they moved to a new address. All noninterviewed households from Wave 1 were automatically designated as noninterviews for all subsequent waves. When original sample persons moved without leaving forwarding addresses, moved to remote parts of the country, or refused to be interviewed, additional noninterviews resulted.

[1]The noninstitutionalized resident population includes persons living in group quarters, such as dormitories, rooming houses, and religious group dwellings. Crew members of merchant vessels, Armed Forces personnel living in military barracks, and institutionalized persons, such as correctional facility inmates and nursing home residents, were not eligible to be in the survey. Also, United States citizens residing abroad were not eligible to be in the survey. With these qualifications, persons who were at least 15 years of age at the time of interview were eligible to be interviewed.

**Noninterviews.** Tabulations in this report were drawn from interviews conducted from January through April 1985. Table C-1 summarizes information on nonresponse for the interview months in which the data used to produce this report were collected.

**Table C-1. Household Sample Size, by Month and Interview Status**

| Month | Eligible | Interviewed | Not interviewed | Nonresponse rate (%) |
|---|---|---|---|---|
| January 1985 | 5600 | 4700 | 900 | *16 |
| February 1985 | 5600 | 4700 | 1000 | 17 |
| March 1985** | 4600 | 3800 | 800 | 18 |
| April 1985 | 4700 | 3800 | 900 | 18 |

* Due to rounding of all numbers at 100, there are some inconsistencies. The percentage was calculated using unrounded numbers.

** Starting in March 1985, a sample cut was implemented for budgetary reasons.

Some respondents do not respond to some of the questions. Therefore, the overall nonresponse rate for some items such as amount of support provided is higher than the nonresponse rates in table C-1. (See appendix D.)

**Estimation.** The estimation procedure used to derive SIPP person weights involved several stages of weight adjustments. In the first wave, each person received a base weight equal to the inverse of his/her probability of selection. For each subsequent interview, each person received a base weight that accounted for following movers.

A noninterview adjustment factor was applied to the weight of every occupant of interviewed households to account for households which were eligible for the sample but were not interviewed. (Individual nonresponse within partially interviewed households was treated with imputation. No special adjustment was made for noninterviews in group quarters.) A factor was applied to each interviewed person's weight to account for the SIPP sample areas not having the same population distribution as the strata from which they were selected.

An additional stage of adjustment to persons' weights was performed to reduce the mean square errors of the sample estimates by ratio adjusting SIPP sample estimates to monthly Current Population Survey (CPS) estimates[2] of the civilian (and some military) noninstitutional population of the United States by age, race, sex, type of householder (married, single with relatives, single without relatives), and relationship to householder (spouse or other). The CPS estimates were themselves brought into agreement with estimates from the 1980 decennial census which were adjusted to reflect births, deaths, immigration, emigration, and changes in the Armed Forces since 1980. Also, an adjustment was made so that a husband and wife within the same household were assigned equal weights.

## RELIABILITY OF ESTIMATES

SIPP estimates in this report are based on a sample; they may differ somewhat from the figures that would have been obtained if a complete census had been taken using the same questionnaire, instructions, and enumerators. There are two types of errors possible in an estimate based on a sample survey: nonsampling and sampling. The magnitude of SIPP sampling error can be estimated, but this is not true of nonsampling error. Found below are descriptions of sources of SIPP nonsampling error, followed by a discussion of sampling error, its estimation, and its use in data analysis.

**Nonsampling variability.** Nonsampling errors can be attributed to many sources, e.g., inability to obtain information about all cases in the sample, definitional difficulties, differences in the interpretation of questions, inability or unwillingness on the part of the respondents to provide correct information, inability to recall information, errors made in collection such as in recording or coding the data, errors made in processing the data, errors made in estimating values for missing data, biases resulting from the differing recall periods caused by the rotation pattern used and failure to represent all units within the universe (undercoverage). Quality control and edit procedures were used to reduce errors made by respondents, coders and interviewers.

Undercoverage in SIPP results from missed living quarters and missed persons within sample households. It is known that undercoverage varies with age, race, and sex. Generally, undercoverage is larger for males than for females and larger for Blacks than for non-Blacks. Ratio estimation to independent age-race-sex population controls partially corrects for the bias due to survey undercoverage. However, biases exist in the estimates to the extent that persons in missed households or missed persons in interviewed households have different characteristics than the interviewed persons in the same age-race-sex group. Further, the independent population controls used have not been adjusted for undercoverage in the decennial census.

The Bureau has used complex techniques to adjust the weights for nonresponse, but the success of these techniques in avoiding bias is unknown.

**Comparability with other estimates.** Caution should be exercised when comparing data from this report with data from earlier SIPP publications or with data from other surveys. The comparability problems are caused by sources such as the seasonal patterns for many characteristics, different nonsampling errors, and by different concepts and procedures in other surveys.

**Sampling variability.** Standard errors indicate the magnitude of the sampling error. They also partially measure the effect of some nonsampling errors in response and enumeration, but do not measure any systematic biases in the data. The standard errors for the most part measure the variations that occurred by chance because a sample rather than the entire population was surveyed.

The sample estimate and its standard error enable one to construct confidence intervals, ranges that would include the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these being surveyed under essentially the same conditions and using the same sample design, and if an estimate and its standard error were calculated from each sample, then:

1. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.

2. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average estimate derived from all possible samples is or is not contained in any particular computed interval. However, for a particular sample, one can say with a specified confidence that the average estimate derived from all possible samples is included in the confidence interval.

**Hypothesis testing.** Standard errors may also be used for hypothesis testing, a procedure for distinguishing between population parameters using sample estimates. The most common types of hypotheses tested are 1) the population parameters are identical versus 2) they are different. Tests may be performed at various levels

[2]These special CPS estimates are slightly different from the published monthly CPS estimates. The differences arise from forcing counts of husbands to agree with counts of wives.

of significance, where a level of significance is the probability of concluding that the parameters are different when, in fact, they are identical.

All statements of comparison in the report have passed a hypothesis test at the 0.10 level of significance or better. Therefore, for most differences cited in the report, the estimated absolute difference between parameters is greater than 1.6 the standard error of the difference ference.

To perform the most common test, compute the difference $X_A$ - X, where $X_A$ and $X_B$ are sample estimates of the parameters of interest. A later section explains how to derive an estimate of the standard error of the difference $X_A - X_B$. Let that standard error be $s_{DIFF}$. If $X_A - X_B$ is between -1.6 times $s_{DIFF}$ and +1.6 times $s_{DIFF}$, no conclusion about the parameters is justified at the 10 percent significance level. If, however, $X_A - X_B$ is smaller than -1.6 times $s_{DIFF}$ or larger than +1.6 times $s_{DIFF}$, the observed difference is significant at the 10 percent level. In this event, it is commonly accepted practice to say that the parameters are different. Of course, sometimes this conclusion will be wrong. When the parameters are, in fact, the same, there is a 10 percent chance of concluding that they are different.

**Note when using small estimates.** Summary measures (such as percent distributions) are shown in the report only when the base is 200,000 or greater. Because of the large standard errors involved, there is little chance that summary measures would reveal useful information when computed on a smaller base. Estimated numbers are shown, however, even though the relative standard errors of these numbers are larger than those for the corresponding percentages. These smaller estimates are provided primarily to permit such combinations of the categories as serve each user's needs. Also, care must be taken in the interpretation of small differences. For instance, in case of a borderline difference, even a small amount of nonsampling error can lead to a wrong decision about the hypotheses, thus distorting a seemingly valid hypothesis test.

**Standard error parameters and tables and their use.** Most SIPP estimates have greater standard errors than those obtained through a simple random sample because clusters of living quarters are sampled for SIPP. To derive standard errors that would be applicable to a wide variety of estimates and could be prepared at a moderate cost, a number of approximations were required. Estimates with similar standard error behavior were grouped together and two parameters (denoted "a" and "b") were developed to approximate the standard error behavior of each group of estimates. These "a" and "b" parameters are used in estimating standard errors and vary by type of estimate and by subgroup to which the estimate applies. Table C-4 provides base "a" and "b" parameters to be used for estimates in this report.

The "a" and "b" parameters may be used to calculate the standard error for estimated numbers and percentages. Because the actual standard error behavior was not identical for all estimates within a group, the standard errors computed from these parameters provide an indication of the order of magnitude of the standard error for any specific estimate. Methods for using these parameters for computation of approximate standard errors are given in the following sections.

For those users who wish further simplification, we have also provided general standard errors in tables C-2 and C-3. Note that these standard errors must be adjusted by an "f" factor from table C-4. The standard errors resulting from this simplified approach are less accurate. Methods for using these parameters and tables for computation of standard errors are given in the following sections.

**Table C-2. Standard Errors of Estimated Numbers of Persons**

(Numbers in thousands)

| Size of estimate | Standard error |
|---|---|
| 200 | 38 |
| 300 | 47 |
| 600 | 66 |
| 1,000 | 86 |
| 2,000 | 120 |
| 5,000 | 189 |
| 8,000 | 237 |
| 11,000 | 276 |
| 13,000 | 298 |
| 15,000 | 318 |
| 17,000 | 336 |
| 22,000 | 376 |
| 26,000 | 404 |
| 30,000 | 428 |
| 50,000 | 512 |
| 80,000 | 562 |
| 100,000 | 555 |
| 130,000 | 482 |
| 135,000 | 461 |
| 150,000 | 372 |
| 160,000 | 281 |

**Standard errors of estimated numbers.** The approximate standard error, $S_x$, of an estimated number of persons can be obtained in two ways. Note that neither method should be applied to dollar values.

It may be obtained by use of the formula

$$S_x = fs \qquad (1)$$

where f is the appropriate "f" factor from table C-4, and s is the standard error on the estimate obtained by interpolation from table C-2. Alternatively, $S_x$ may be approximated by the formula

**Table C-3. Standard Errors of Estimated Percentages of Persons**

| Base of estimated percentage (thousands) | Estimated percentage | | | | | |
|---|---|---|---|---|---|---|
| | s 1 or r 99 | 2 or 98 | 5 or 95 | 10 or 90 | 25 or 75 | 50 |
| 200 | 1.9 | 2.7 | 4.2 | 5.8 | 8.3 | 15.8 |
| 300 | 1.6 | 2.2 | 3.4 | 4.7 | 6.8 | 12.9 |
| 600 | 1.1 | 1.6 | 2.4 | 3.2 | 4.8 | 9.1 |
| 1,000 | 0.86 | 1.2 | 1.9 | 2.6 | 3.7 | 7.1 |
| 2,000 | 0.60 | 0.85 | 1.3 | 1.8 | 2.6 | 5.0 |
| 5,000 | 0.38 | 0.54 | 0.84 | 1.2 | 1.7 | 3.2 |
| 8,000 | 0.30 | 0.43 | 0.66 | 0.91 | 1.3 | 2.5 |
| 11,000 | 0.30 | 0.36 | 0.56 | 0.78 | 1.1 | 2.1 |
| 13,000 | 0.24 | 0.33 | 0.52 | 0.72 | 1.0 | 2.0 |
| 17,000 | 0.21 | 0.29 | 0.45 | 0.63 | 0.90 | 1.7 |
| 22,000 | 0.18 | 0.26 | 0.40 | 0.55 | 0.80 | 1.5 |
| 26,000 | 0.17 | 0.24 | 0.37 | 0.51 | 0.73 | 1.4 |
| 30,000 | 0.16 | 0.22 | 0.34 | 0.47 | 0.68 | 1.3 |
| 50,000 | 0.12 | 0.17 | 0.26 | 0.36 | 0.53 | 1.0 |
| 80,000 | 0.10 | 0.13 | 0.21 | 0.29 | 0.42 | 0.79 |
| 100,000 | 0.09 | 0.12 | 0.19 | 0.26 | 0.37 | 0.71 |
| 130,000 | 0.08 | 0.11 | 0.16 | 0.23 | 0.33 | 0.62 |
| 220,000 | 0.06 | 0.08 | 0.13 | 0.17 | 0.25 | 0.48 |

$$S_x = \sqrt{ax^2 + bx} \qquad (2)$$

from which the standard errors in table C-2 were calculated. Here x is the size of the estimate and "a" and "b" are the parameters associated with the particular type of characteristic being estimated. Use of formula 2 will provide more accurate results than the use of formula 1 above.

*Illustration.* SIPP estimates from text table B of this report show that 1,949,000 people provide support for adults only. The appropriate "a" and "b" parameters and "f" factor from table C-4 and the appropriate general standard error from table C-2 are
a = -0.000431, b = 7,390, f = 1.00, s = 118,000

Using formula 1, the approximate standard error is
1.00 X 118,000 = 118,000
and using formula 2, the approximate standard error is

$$\sqrt{(-0.0000431)\ (1{,}949{,}000)^2 + (7{,}390)\ (1{,}949{,}000)} = 119{,}000$$

The 90-percent confidence interval as shown by the data is from 1,758,600 to 2,213,400. Therefore, a conclusion that the average estimate derived from all possible samples lies within a range computed in this way would be correct for roughly 90 percent of all samples.

**Standard error of a mean.** A mean is defined here to be the average quantity of some item (other than persons, families, or households) per person, family, or household. For example, it could be the average monthly household income of females age 25 to 34. The standard error of a mean can be approximated by formula (3) below. Because of the approximations used in developing formula (3), an estimate of the standard error of the mean obtained from that formula will generally underestimate the true standard error. The formula used to estimate the standard error of a mean x is

$$S_x = \sqrt{\frac{b}{y} S^2} \qquad (3)$$

where y is the size of the base, $S^2$ is the estimated population variance of the item and b is the parameter associated with the particular type of item.

The estimated population variance, $S^2$, is given by the formula:

$$S^2 = \sum_{i=1}^{c} p_i x_i^2 - x^2$$

where it is assumed that each person or other unit was placed in one of c groups: $p_i$ is the estimated proportion of group i; $x_i = (Z_{i-1} + Z_i)/2$ where $Z_{i-1}$ and $Z_i$ are the lower and upper interval boundaries, respectively, for group i. The value $x_i$ is assumed to be the most representative value for the characteristic of interest in group i. If group c is open-ended, i.e., no upper interval boundary exists, then an approximate value for $x_c$ is

**Table C-4. SIPP Generalized Variance Parameters**

| Persons | a | b | f factor |
|---|---|---|---|
| Total or White | -0.0000431 | 7,390 | 1.00 |
| Black | -0.0002628 | 5,106 | 0.83 |

$$x_c = \frac{3}{2} Z_{c-1} \qquad (0)$$

**Standard errors of estimated percentages.** The reliability of an estimated percentage, computed using sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. When the numerator and denominator of the percentage have different parameters, use the parameter (and appropriate factor) of the numerator. If proportions are presented instead of percentages, note that the standard error of a proportion is equal to the standard error of the corresponding percentage divided by 100.

There are two types of percentages commonly estimated. The first is the percentage of persons sharing a particular characteristic such as the percent of persons owning their own home. The second type is the percentage of money or some similar concept held by a particular group of persons or held in a particular form. Examples are the percent of wealth held by persons with high income and the percent of income for persons on welfare.

For the percentage of persons, the approximate standard error, $S_{(x,p)}$, of the estimated percentage p can be obtained by the formula

$$S_{(x,p)} = fs \qquad (4)$$

In this formula, f is the appropriate "f" factor from table C-4 and s is the standard error on the estimate from table C-3. Alternatively, $S_{(x,p)}$ it may be approximated by the formula

$$S_{(x,p)} = \sqrt{\frac{b}{x} p\,(100-p)} \qquad (5)$$

from which the standard errors in table C-3 were calculated. Here x is the size of the subclass of persons which is the base of the percentage, p is the percentage ($0 < p < 100$), and b is the "b" parameter associated with the characteristic in the numerator. Use of this formula will give more accurate results than use of formula 4 above.

For percentages of money, a more complicated formula is required. A percentage of money will usually be estimated in one of two ways. It may be the ratio of two aggregates:

$$P_M = \frac{X_A}{X_N}$$

or it may be the ratio of two means with an adjustment for different bases:

$P_M = p_A x_A / x_N$

where $X_A$ and $X_N$ are aggregate money figures, $x_A$ and $x_N$ are mean money figures, and $p_A$ is the estimated number in group A divided by the estimated number in group N. In either case, we estimate the standard error as

$$S_M = \sqrt{\left[\frac{p_A x_A}{x_N}\right]^2 \left[\left(\frac{s_p}{p_A}\right)^2 + \left(\frac{s_A}{x_A}\right)^2 + \left(\frac{s_B}{x_N}\right)^2\right]} \qquad (6)$$

where $s_p$ is the standard error of $p_A$, $s_A$ is the standard error of $x_A$ and $s_B$ is the standard error of $x_N$. To calculate $s_p$, use formula (5). The standard errors of $x_N$ and $x_A$ may be calculated using formula (3).

It should be noted that there is frequently some correlation between the characteristics estimated by $p_A$, $x_N$, and $x_A$. If these correlations are positive, then formula (6) will tend to overestimate the true standard error; if they are negative, underestimates will tend to result.

*Illustration.* Text table A shows that an estimated 28.9 percent of persons who receive support are adults. Using formula 4 with the "f" factor from table C-4 and the appropriate standard error from table C-3, the appropriate standard error is

$S_{(x,p)} = 1.00 \times 1.3\% = 1.3\%$ .

Using formula 5 with the "b" parameter from table C-4, the approximate standard error is

$$S_{(x,p)} = \sqrt{\frac{7{,}390}{9{,}914{,}000} 28.9\%\,(100\% - 28.9\%)} = 1.2\%$$

Consequently, the 90-percent confidence interval as shown by these data is from 27.0 to 30.8 percent.

**Standard error of a difference.** The standard error of a difference between two sample estimates is approximately equal to

$$S_{(x-y)} = \sqrt{S_x^2 + S_y^2} \qquad (7)$$

where $S_x$ and $S_y$ are the standard errors of the estimates x and y.

The estimates can be numbers, percents, ratios, etc. The above formula assumes that the correlation coefficient, r, between the characteristics estimated by x and y is zero. If r is really positive (negative), then this assumption will tend to cause to overestimates (underestimates) of the true standard error.

*Illustration.* Using text table A, 9.3 percent of the adults who receive support are the parents of the provider and 4.2 percent of the adults who receive support are the ex-spouses of the provider. The standard errors for these percentages are computed using formula 5, to be

0.8 and 0.3 percent. Assuming that these two estimates are not correlated, the standard error of the estimated difference of 5.1 percentage points is

$$S_{(x-y)} = \sqrt{(0.8\%)^2 + (0.3\%)^2} = 0.7\%$$

The 90-percent confidence interval is from 4.0 to 6.2 percentage points. Since this interval does not contain zero, we conclude that the difference is significant at the 10-percent level.

**Standard errors of ratios of means.** The standard error for a ratio of means is approximated by:

$$S_{(x/y)} = \sqrt{\left(\frac{x}{y}\right)^2 \left[\left(\frac{s_y}{y}\right)^2 + \left(\frac{s_x}{x}\right)^2\right]} \qquad (8)$$

where x and y are the means, and $s_x$ and $s_y$ are their associated standard errors. Formula 8 assumes that the means are not correlated. If the correlation between the population means estimated by x and y are actually positive (negative), then this procedure will tend to produce overestimates (underestimates) of the true standard error for the ratio of means.